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EXPERIMENTAL STUDY ON DAMPING PROPERTIES OF SISAL/FLAX FIBRE REINFORCED COMPOSITE MATERIAL

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ABSTRACT

Today's most of the industries are generally using glass fibres and carbon fibres for better strength, low weight, and corrosion resistance. The main limitations of these materials are the availability, non biodegradable, health hazardous and their fabrication cost, hence the aim of this research is to replace these materials with natural fibers such as Flax and Sisal.

In this research work damping properties of Flax and Sisal fiber reinforced composites their constituents and manufacturing technologies will be reviewed.

Key words: Flax, Sisal, Polymers, Multiaxial Reinforcement.

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1. INTRODUCTION

A wide variety of sources including wood, coal, coke, oil, natural gas and nuclear materials have been used to generate energy. Over the years, the consumption of energy has increased due to the increasing population and civilization [1,3]. At the same time, the ecological awareness has become the major environmental issue in the global marketplace. In today's scenario the major threat for the environment is the imbalance in the ecological system which is increasing due to the disposal of toxic waste. This issue has led to the increased interest on renewable and sustainable energy sources [9, 13]. The only concern for the sustainable development is minimum pollution and reduction in energy consumption [2].

Natural fibers are an appealing exploration region since they are eco accommodating, economical, abundant and renewable, lightweight, low density, high toughness, high particular properties, biodegradability and non -grating to handling qualities, Therefore, regular strands can serve as fortifications by enhancing the quality and firmness furthermore by lessening the heaviness of the subsequent bio composite materials in spite of the fact that the properties of characteristic fibers differ with their source and medicines[11,13]. Sisal fiber is completely biodegradable, green composites were produced with soy macromolecule tar modified with gelatin. It is exceedingly renewable resource of essentiality. Sisal fiber is especially solid and a low backing with unimportant wear and

tear. Flax fiber is delicate, shining and flexible [17, 18, and 20]. It is extra grounded than cotton fiber yet less versatile. The most straightforward grades are utilized for material fabrics, for case, damasks, strip and sheeting [15].

2. DAMPING TEST

The hand lay-up technique is used for the fabrication of hybrid sisal-flax laminate. Sisal and flax fiber as reinforced materials and industrially accessible epoxy resin as a matrix material. A cantilevered rectangular symmetric plate of hybrid sisal-flax fabric fortified epoxy composite having measurements 300x300x5 mm [6].

Figure 2.1 Damping test specimen **Figure 2.2** Experimental setup

The Fast Fourier Technique (FFT) is a fundamental measurement that isolates and inherent dynamic mechanical properties of the structure [22,24]. Frequency, damping and mode shapes will be obtained from the Fast Fourier Technique [28].

A matrix of 7x6 (42 focuses) estimation focuses are set apart over the surface of the laminates. The laminate is then braced on test apparatus and an impulse method was utilized to energize the structure by effect hammer with force transducer worked into the tip to enroll the force input [28]. The impact force of the hammer will be within the 4-6 KN will be taken. Beyond the 6 KN or before the 4 KN and force of frequency not be accepted and the rebounding frequency also not accepted. The excitation signal is encouraged to the analyser through amplifier unit [30]. A piezoelectric accelerometer stuck on the wanted measuring purpose of the specimen detects the subsequent vibration reaction. The accelerometer signals were molded in the charge amplifier and fed to the analyser. The analyser in conjunction with Fast Fourier Transform (FFT) gives connection amongst time and Frequency Response Spectrum (FRS) and intelligence capacities are enlisted in the chose recurrence range. At every lattice point five estimations were made and their average was obtained. The yield information of every one of the 42 estimations was utilized as an information for LABVIEW-2009 software to recognize response frequencies [33,35]. The natural frequencies, damping factor and mode shapes for various laminates were obtained [39].

2.1. Steps Involved in Damping Testing

After the laminate fixed and while impacting the setup can be done in the LABVIEW- 2009 software.

Step – 1: Start the Labview – 2009 software and open the vibration analysis and type the average count for taking the natural frequencies and damping factor.

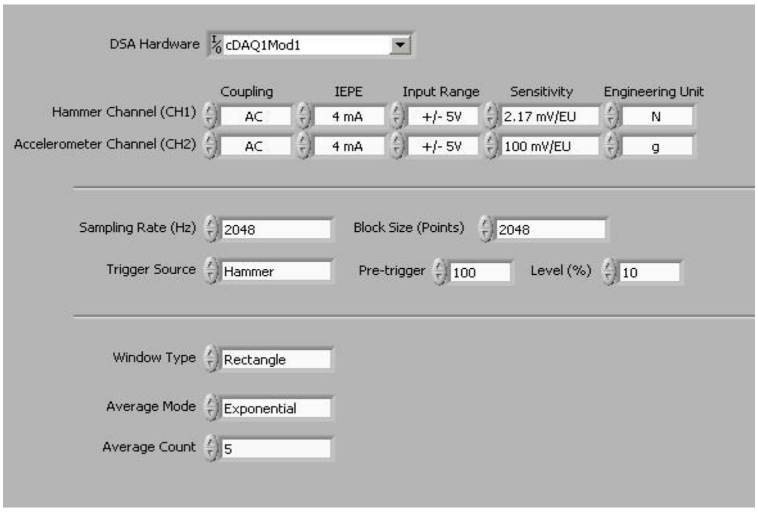


Figure 2.3 Labview software vibration analysis command

Step – 2: Type the x and y grid axis to create the nodes.

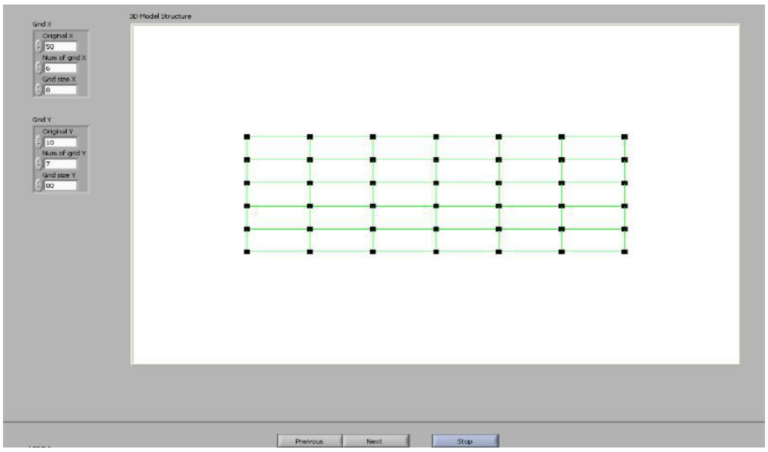


Figure 2.4 Grid X and Y axis

Step – 3: After the nodes created and excite the structure by an impact hammer with force transducer, the force within the 4-6 KN. Beyond the 6 KN or before the 4 KN and force of frequency not be accepted and the rebounding frequency also not accepted.

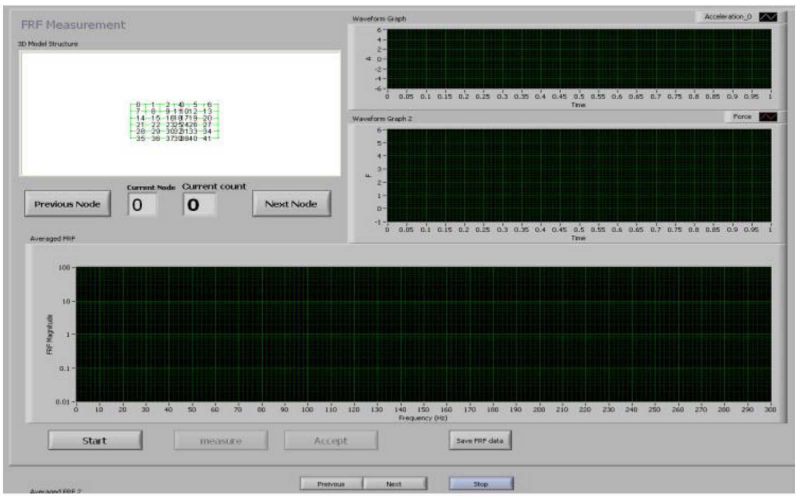


Figure 2.5 Impact force within 4-6 KN

Step – 4: After excite the structure by an impact hammer at first node between the 4-6 KN force of frequency will be accepted.

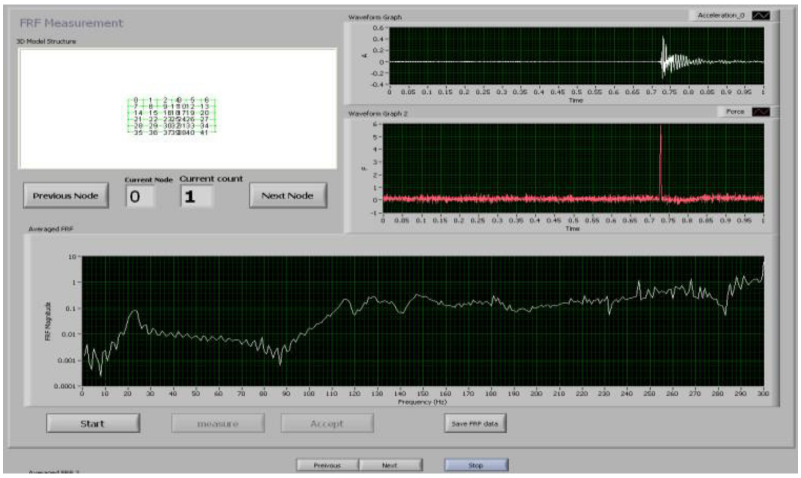


Figure 2.6 Frequency at first node

Step – 5: The procedure continues by taking the frequencies up to 42 nodes with the help of impact hammer and piezoelectric transducer.

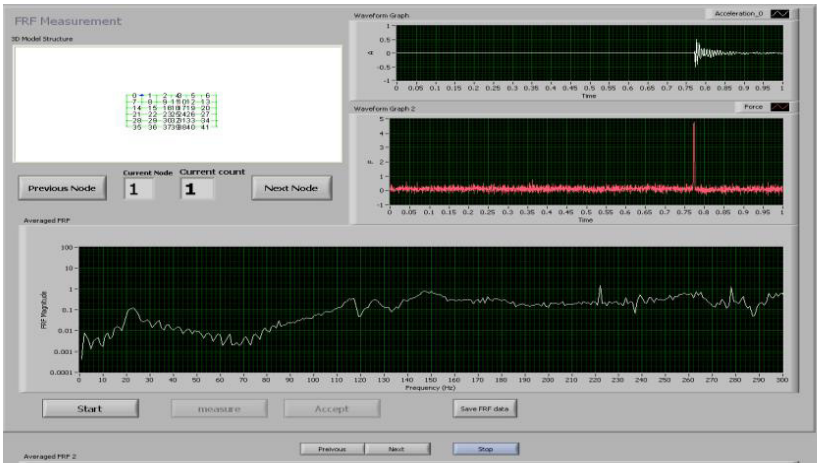


Figure 2.7 Frequency at first node

Step – 6: Natural frequency at 41st node

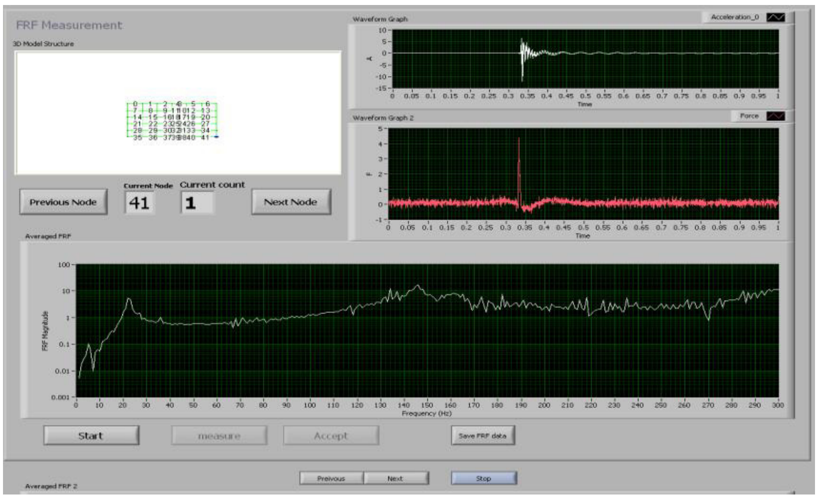


Figure 2.8 Natural frequency at 41st node

3. DAMPING TEST

Table 3.1 for 20% Sisal+5% Flax+75% Epoxy Resin

PMC	Mode Number	Frequency (Hz)	Damping Factor (%)	Magnitude	Phase Angle Degree
20% Sisal +5% Flax	1	21.150	1.807	0.048804	165.65
	2	48.082	2.510	0.012122	179.82
	3	151.795	2.430	0.945035	170.75
	4	173.365	2.406	0.280577	178.18
	5	290.085	1.045	1.152303	161.95

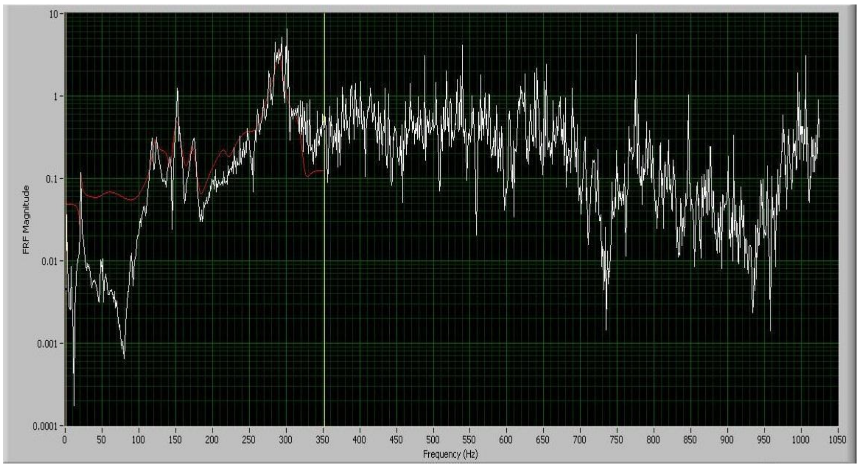


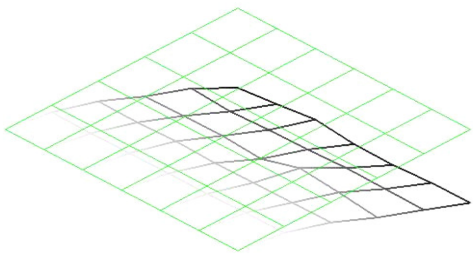
Figure 3.1 FRF sisal+flax+epoxy resin composition

3.1. Mode Shapes for 20%Sisal+5%Flax+75%Epoxy Resin

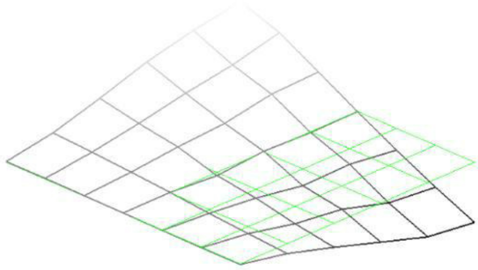
Mode Shape – 1: Bending

Frequency – 21.150 Hz

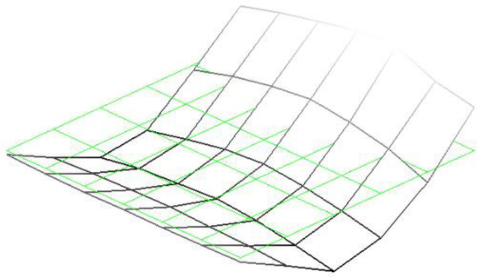
Material Damping Factor – 1.807 %



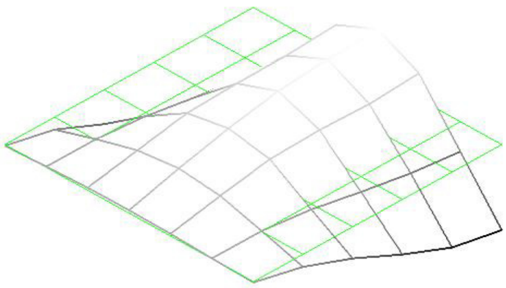
Mode Shape – 2: Twisting
Frequency – 48.082 Hz
Material Damping Factor – 2.510 %



Mode Shape – 3: Double Bending
Frequency – 151.795 Hz
Material Damping Factor – 2.430 %



Mode Shape – 4: Combination of Bending and Twisting
Frequency – 173.365 Hz
Material Damping Factor – 2.406 %



Mode Shape -5
Frequency – 290.085 Hz
Material Damping Factor – 1.045 %

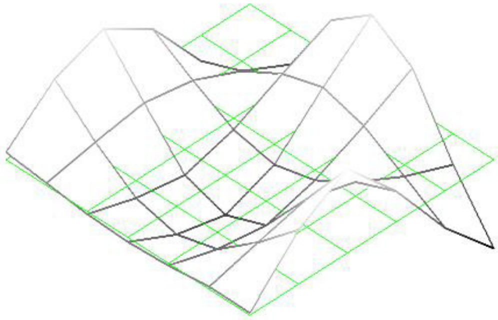


Table 3.2 for 20%Sisal+5%Flax+75%Epoxy Resin

PMC	Mode Number	Frequency (Hz)	Damping Factor (%)	Magnitude	Phase Angle Degree
20% Sisal +10% Flax	1	19.373	0.732	0.120390	143.17
	2	40.209	1.211	0.006214	132.90
	3	118.362	2.943	2.031173	146.24
	4	144.124	1.181	0.239629	148.40
	5	232.136	0.822	0.801060	81.283

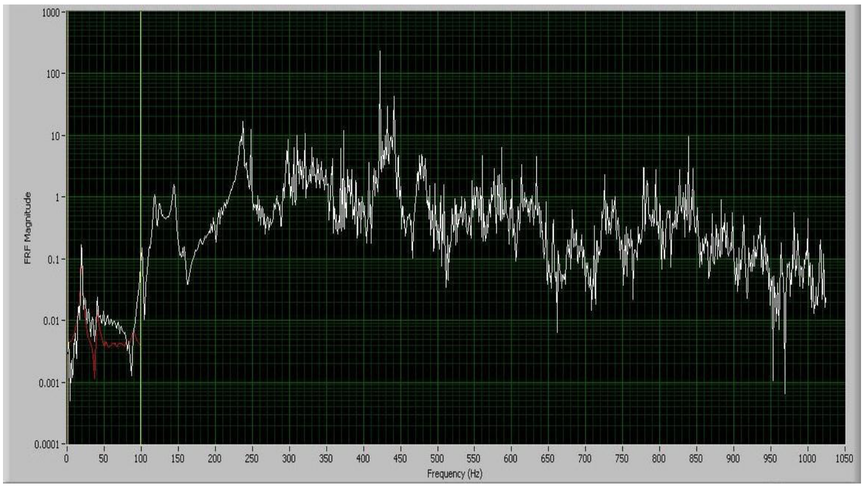
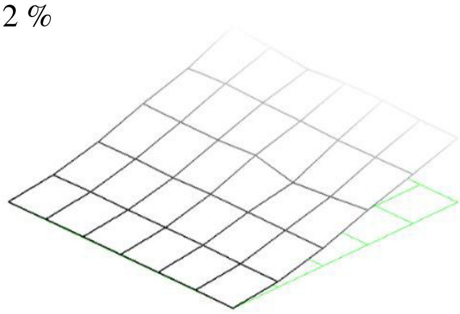


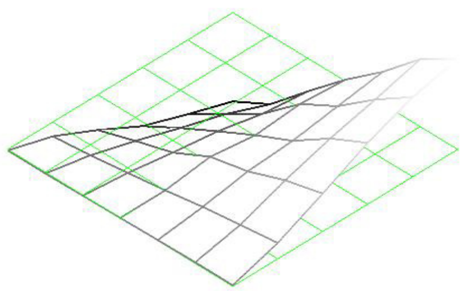
Figure 3.2 FRF sisal+flax+epoxy resin composition

3.2. Mode Shapes for 20%Sisal+10%Flax+70%Epoxy Resin

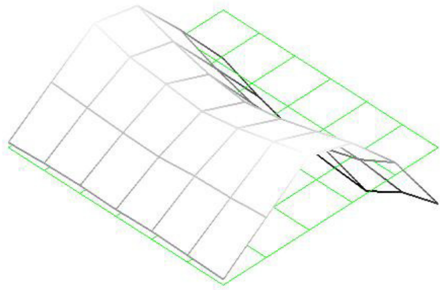
Mode Shape – 1: Bending
Frequency – 19.373 Hz
Material Damping Factor – 0.732 %



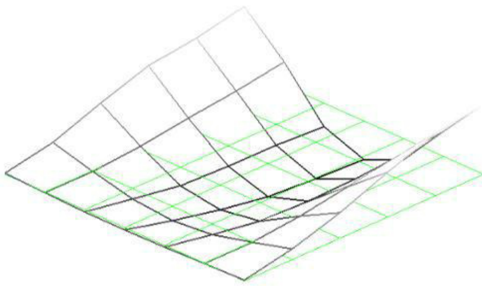
Mode Shape – 2: Twisting
Frequency – 40.209 Hz
Material Damping Factor – 1.211 %



Mode Shape – 3: Double Bending
Frequency – 118.362 Hz
Material Damping Factor – 2.943 %



Mode Shape – 4: Combinations of Bending and Twisting
Frequency – 144.124 Hz
Material Damping Factor – 1.181 %



Mode Shape – 5
Frequency – 232.136 Hz
Material Damping Factor – 0.822 %

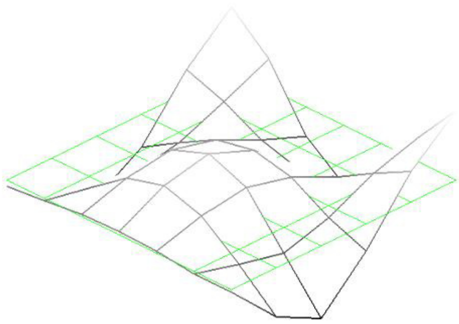


Table 3.3 20%Sisal+15%Flax+65%Epoxy Resin

PMC	Mode Number	Frequency (Hz)	Damping Factor (%)	Magnitude	Phase Angle Degree
20% Sisal +15% Flax	1	18.382	2.282	0.073329	144.280
	2	40.386	2.488	0.054698	62.947
	3	105.940	2.347	0.296280	106.392
	4	122.007	2.544	1.331027	105.33
	5	150.347	3.848	0.292209	129.803

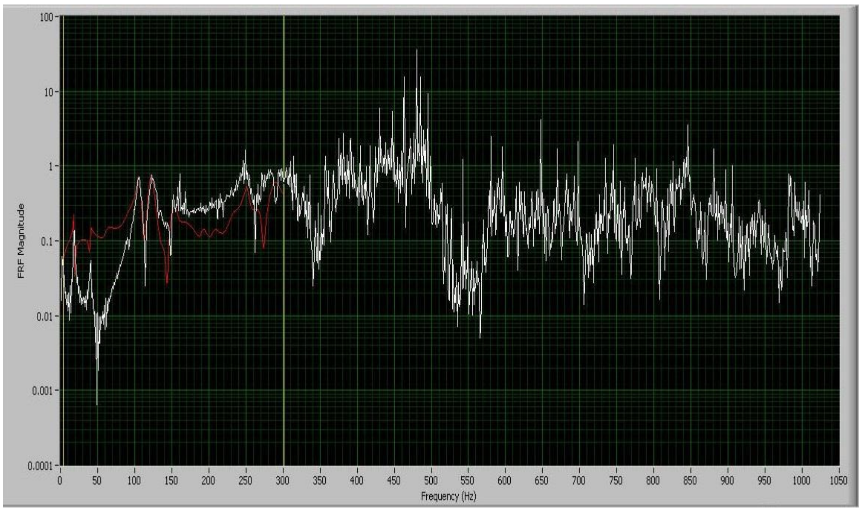


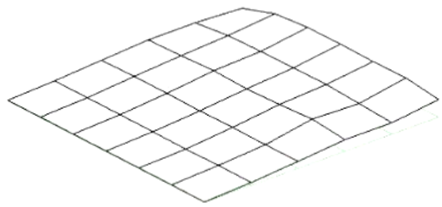
Figure 3.3 FRF sisal+flax+epoxy resin composition

3.3. Mode Shapes for 20%Sisal+15%Flax+65%Epoxy Resin

Mode Shape – 1: Bending

Frequency – 18.382 Hz

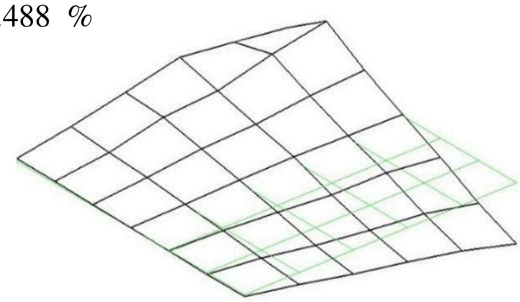
Material Damping Factor – 2.282 %



Mode Shape – 2: Twisting

Frequency – 40.386 Hz

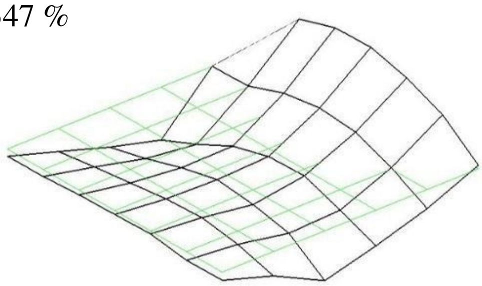
Material Damping Factor – 2.488 %



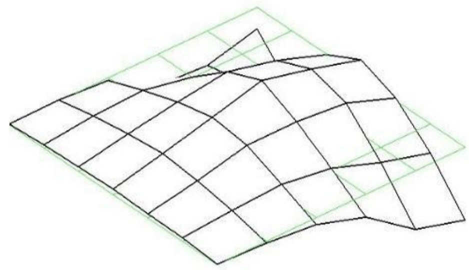
Mode Shape -3 : Double Bending

Frequency – 105.94 Hz

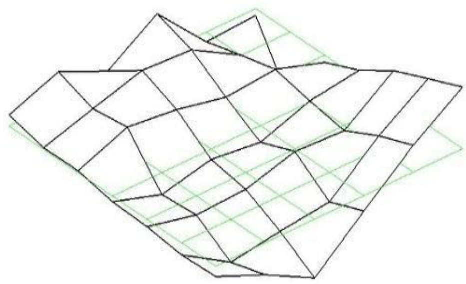
Material Damping Factor – 2.347 %



Mode Shape – 4 : Combination of Bending and Twisting
Frequency – 122.007 Hz
Material Damping Factor – 2.544 %



Mode Shape – 5
Frequency – 150.347 Hz
Material Damping Factor – 3.848 %



4. RESULT

- Table 3.1, table 3.2 and table 3.3 shows corresponding values for frequency, material damping factor, magnitude and phase angle of the composite plate.
- The figure 3.1, figure.3.2 and figure.3.3 shows the FRF magnitude versus frequency for the hybrid composite 20% Sisal+5% Flax+75% Epoxy resin, 20% Sisal+10% Flax+70% Epoxy resin and 20% Sisal+15% Flax+65% Epoxy resin composite plate.
- The natural frequency (290.08 Hz) highly increases at 20% Sisal+5% Flax+75% Epoxy resin composite plate shown in table 7.10 and different modes shown in the natural frequency in figure.7.26
- The natural frequency (232.13 Hz) is comparatively low at 20% Sisal+10% Flax+70% Epoxy resin composite plate shown in table 7.11 and different modes shown in the natural frequency in figure.7.28
- The natural frequency (150.34 Hz) is low, the composition 20% Sisal+15% Flax+65% Epoxy resin composite plate shown in table 7.12 and different modes shown for the natural frequency in figure.7.30.

5. CONCLUSION

Glass fibre and carbon fibre reinforced composites are still non-biodegradable in nature. For this reason, scientists and engineers are constantly focusing on replacing the existing material with bio-degradable materials. Natural fibre reinforced composites form one such class of materials which not only possess superior mechanical properties but are also bio-degradable in nature. Natural fibre reinforced composites can be a potential candidate where they can replace the conventional material system.

From above results it is concluded that low frequency material that is combination of 20% Sisal+15% Flax or 35% of natural fibre reinforced materials are eligible to replace glass fibre reinforced composites for some industrial applications such as small wind turbine blades,

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